Wed Sept 17th 2014.

CIVL 498C Life Cycle Assessment

Week 3: Goal & Scope

Goal & Scope
Setting up an LCA study

Presentation Outline

1. **ISO-LCA G&S exercise**
2. G&S parameters

ISO-LCA Goal & Scope Parameters

- In groups of 3, use ISO 14044 and group discussion come up with 1-sentence descriptions for each parameter in your exercise sheet.

Presentation Outline

1. ISO-LCA G&S exercise
2. **G&S parameters**

Life Cycle Assessment

Guiding Standards

- **ISO 14040**:2006, Environmental management – Life cycle assessment – **Principles and framework**

- **ISO14044**:2006; Environmental management – Life cycle assessment- **Requirements and guidelines**

Sustainability

Inventory Analysis

Impact Assessment

Resources

Energy

Investment

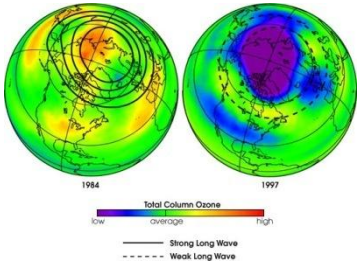
Air

Water

Land

Costs

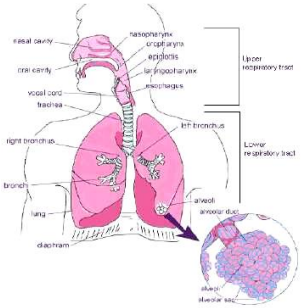
kg CO2 eq



kg CFC-11 eq

kg SO2 eq

NPV CAD$



kg PM10 eq

kg N eq

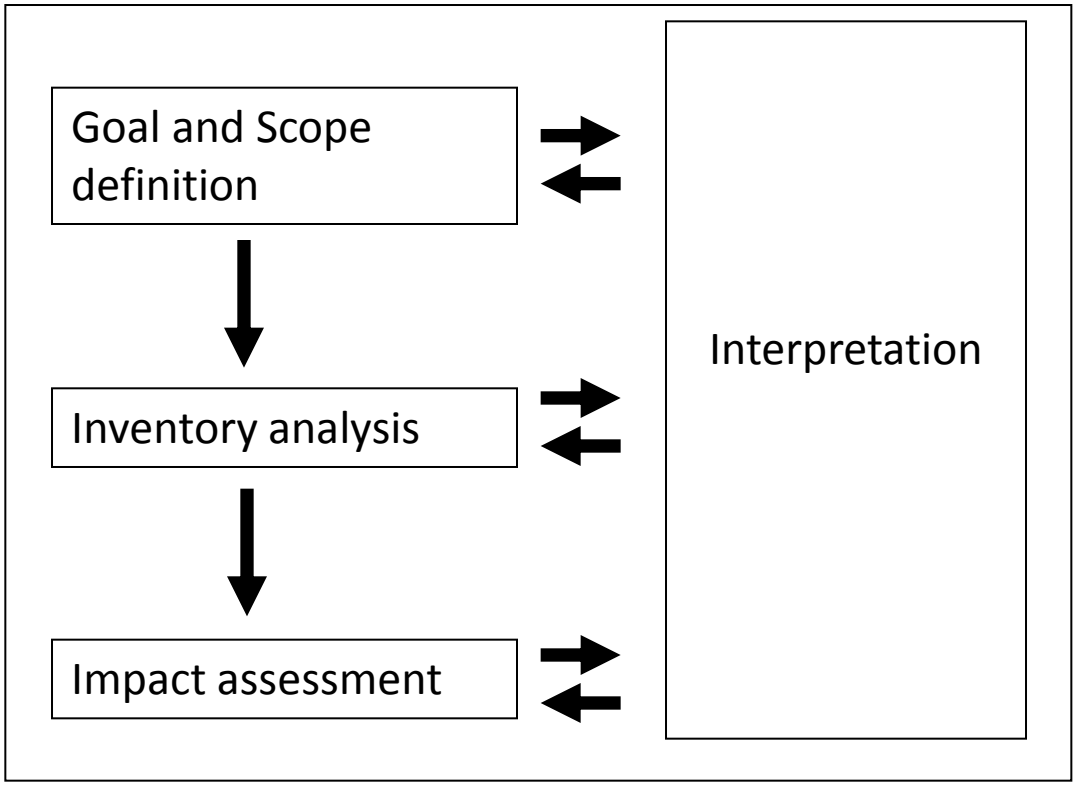
kg O3 eq

Life Cycle Assessment Framework

Defining and planning the study to be carried out on the system in question.

Measuring physical inputs and outputs from the system in question.

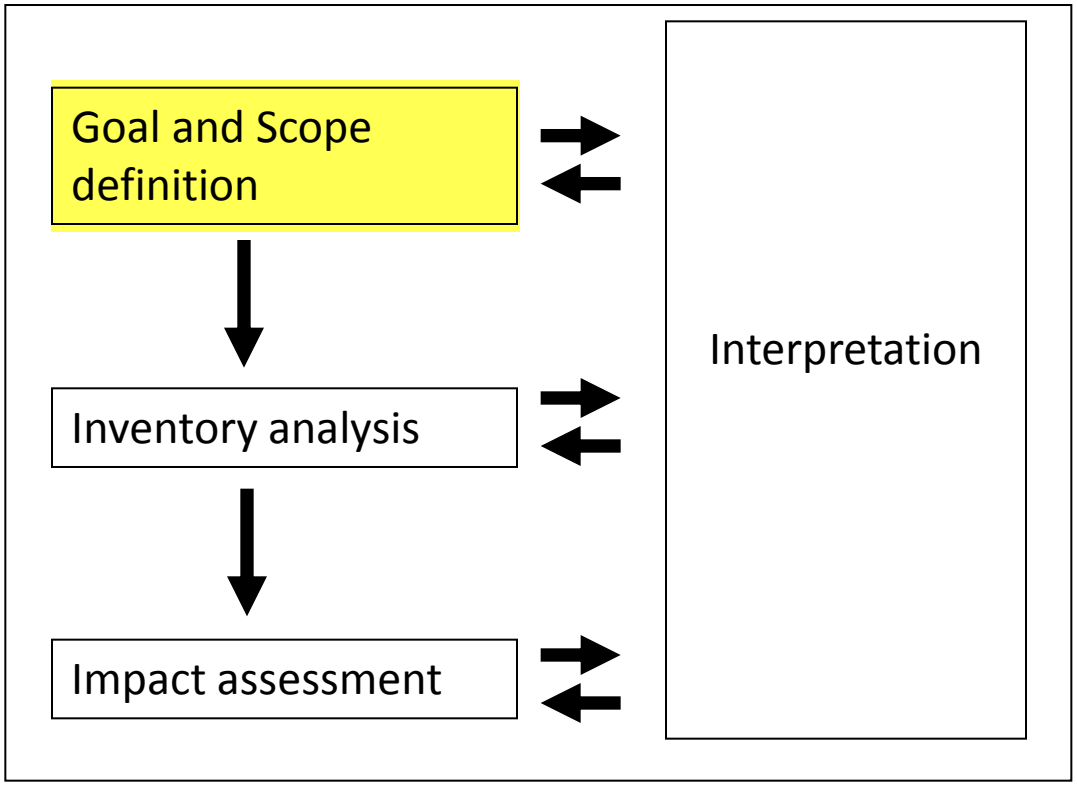
Assigning an environmental significance to inputs and outputs from the system in question.



(ISO 14040:2006)

ISO LCA Methodological Framework

Defining and planning the study to be carried out on the system in question.



(ISO 14040:2006)

Goal & Scope

State the;

- Intended application
- Reasons for carrying out the study
- Intended audience
- Intended for comparative assertions

(ISO 14044:2006)

All information related to modeling that is to be carried out, specifically the;

- Product system to be studied
- Functions of the product system or, in the case of comparative studies, the systems
- Functional unit
- System boundary
- Impact categories selected and methodology of impact assessment, subsequent interpretation to be used
- Allocation procedures
- Data requirements
- Data quality requirements
- Assumptions
- Limitations
- Type of critical review, if any
- Type and format of the report required for the study

Goal

State the;

- Intended application
- Reasons for carrying out the study
- Intended audience
- Intended for comparative assertions

Goal

State the;

- Intended application
  - Where will you put this information to use?
  - Again, be as specific as possible

ISO 14040:2006 intended use areas of a LCA;

- Support product development,
- Strategic planning,
- Marketing, and
- Policy making

Example applications from Quantis XLERATOR LCA study;

> *"[This study] is intended to provide these audiences with information needed to make a valid comparison of the life cycle environmental impacts of the [XLERATOR vs. Conventional Hand Dryer vs. Paper Towel] systems in question."*

Example from Prairie Pulp and Paper study;

To provide technical marketing documentation to inform consumer paper purchasing decisions.

Goal

State the;

- Reasons for carrying out the study
  - Describe objectives and motivations that provide context to the need for the study
  - Provide an upfront discussion and be as specific as possible, ie. organizations, object(s) of assessment.
  - Ties in closely with your intended applications, is often combined with it.

Examples:

- Motivations
  - Pressure from regional regulations, meet industry standards, company culture
- Objectives
  - to compare different product use phase scenarios' energy consumption and global warming impacts.
  - to identify the largest contributors to global warming and ozone layer depletion in a product's supply chain from extraction up to the products manufacturing gate.

Goal

State the;

- Reasons for carrying out the study
  - Describe objectives and motivations that provide context to the need for the study
  - Provide an upfront discussion and be as specific as possible, ie. organizations, object(s) of assessment.
  - Ties in closely with your intended applications, is often combined with it.

Examples:

To support decisions on governmental non-binding recommendations that address the environmental risks associated with the management of paper waste produced by commercial and governmental office operations in Australia.

Adapted from - http://center.sustainability.duke.edu/sites/default/files/documents/lca_guidance.pdf

Prairie Pulp & Paper's *Step Forward PaperTM (Step Forward) is a Canadian wheat paper manufacturer with sustainability at the core of it's business strategy*. This LCA study provides a comparison of cradle-to-grave life cycle environmental impacts of Step Forward against other copy paper types sold in the North American marketplace.

Adapted from - http://stepforwardpaper.com/wp-content/uploads/2013/02/Step-Forward-Life-Cycle-Study-PPP-121024.pdf

Goal

State the;

- Intended audience
  - Identify the groups who you are preparing the study to be understood and used by
  - This should be taken into consideration in the language used and details highlighted in communication documents (ie. EPD vs. ecolabel)

Examples of potential audiences of an LCA study;

- Product developers,
- Management,
- Customers, and
- Researchers


R & D


Investors

Goal

State the;

- Intended for comparative assertions
  - Do you want to make environmental claims regarding competing products that serve the same functions? If so,
    - make sure the products you are comparing are functionally equivalent with similar modeling considerations or
    - match the LCA study you are going to compare against
    - check to see if the product(s) you plan on studying have pre-existing product category rules (PCRs)

Goal & Scope

State the;

- Intended application
- Reasons for carrying out the study
- Intended audience
- Intended for comparative assertions

(ISO 14044:2006)

All information related to modeling that is to be carried out, specifically the;

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- Data quality requirements
- Assumptions
- Limitations
- Type of critical review, if any
- Type and format of the report required for the study

Scope

- Product system to be studied
  - Describes the collection of unit processes that will be included in the study.
- Functions of the product system
  - Describes the functions served by the product focused on in the LCA study.

For example from LCA of Organic vs. Conventional milk production;

2.4. Studied objects

Data were collected from two relatively large dairy farms in the west of Sweden which are run by an Agriculture Society and follow a current commercial production scheme. These farms were chosen since there were production data of very high quality (e.g. all fodder is weighed), and because they are specialised milk producers, which means there are no other co-products except meat from the farms. Another important reason for choosing two individual enterprises was that there are no Swedish statistics available on average energy use and land use in different milk production systems. Both farms grow all roughage fodder for their own use which is customary for Swedish dairy farms. The use of concentrate feed on the conventional farm is high but such is the case for many Swedish conventional dairy farms today. The use of diesel in the farms' crop production and the use of fertiliser on the conventional farm have been compared with data from other farms and appear to be within a normal range. The yield of grain and peas on the organic farm is relatively low which probably leads to a proportionately large use of arable land.

As roughage fodder, the conventional farm used 2267 kg DM grass silage and 687 kg DM pressed beet pulp[3] per cow. The organic farm used both silage and hay as roughage fodder, 1869 kg DM and 1355 kg respectively per cow. The intake of pasture was 775 kg DM per organic cow, more than double that of the conventional farm. The grain consumption was 25% higher per cow on the conventional farm. While the organic farm used 1000 kg peas per cow (produced on the farm and on a neighbouring farm) and purchased concentrate feed[4] corresponding to 343 kg per cow, the conventional farm used 1531 kg purchased concentrate feed[5] per cow. On the conventional farm each cow produced 7.813 FU and on the organic farm the milk production was 7.127 FU per cow.

Scope

- Functional unit
  - A performance characteristic of the product system being studied that will be used as a reference unit to normalize the results of the study.
  - What, how much, and how long function is provided. Quality and function changes?

Examples applications from:

Quantis XLERATOR LCA study;

The functional unit for this study is *to dry 260,000 pairs of hands.*

LCA of Organic vs. Conventional milk production;

The functional unit (FU) was 1000 kg energy corrected milk (ECM) leaving the farm gate.

LCA of different transportation methods using multiple functional units;

per passenger mile travelled in a year (PMT)
per vehicle miles traveled in a year (VMT)
per vehicle lifetime
per tonne*kilometer (tkm)

*reflect on Goals..

Wall Structure

per m2 of wall constructed to building code with 60 year service life

Scope

- Functional unit
  - A performance characteristic of the product system being studied that will be used as a reference unit to normalize the results of the study.
  - What, how much, and how long function is provided. Quality and function changes?

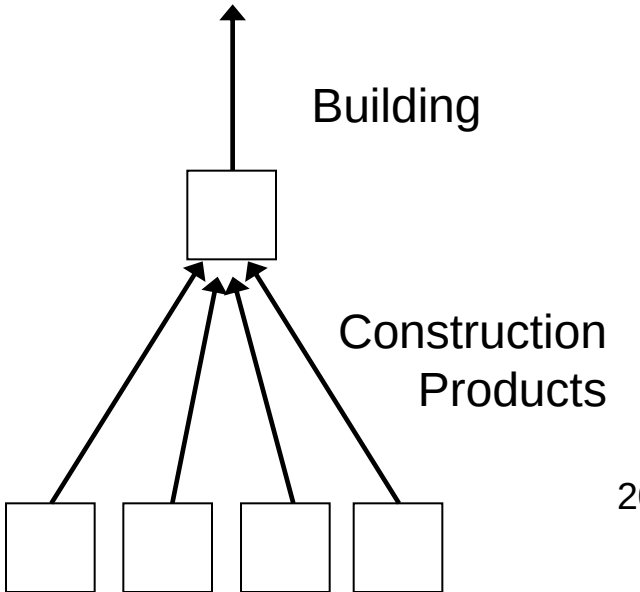
  - per whole building ..
  - per m^2 floor area ..

Reference Flow:

outputs from system required to fulfill the function expressed by the functional unit.

Intermediate Flow:

output from a process that is input to other process that requires further transformation within system.



Scope

- Functional unit
  - A performance characteristic of the product system being studied that will be used as a reference unit to normalize the results of the study.
  - What, how much, and how long function is provided. Quality and function changes?

Examples applications from:

How to compare TVs?

How to compare cell phones?

How to compare deodorants?

How to compare buildings?... Olympic Arenas?

Scope

- System boundary
  - Details the extent of the product system to be studied in terms of product components, life cycle stages, and unit processes.
  - Really need to reflect on what you're trying to achieve in this study (ie. reflect on your Goal) to ensure study is as complex as necessary but as simple as possible.

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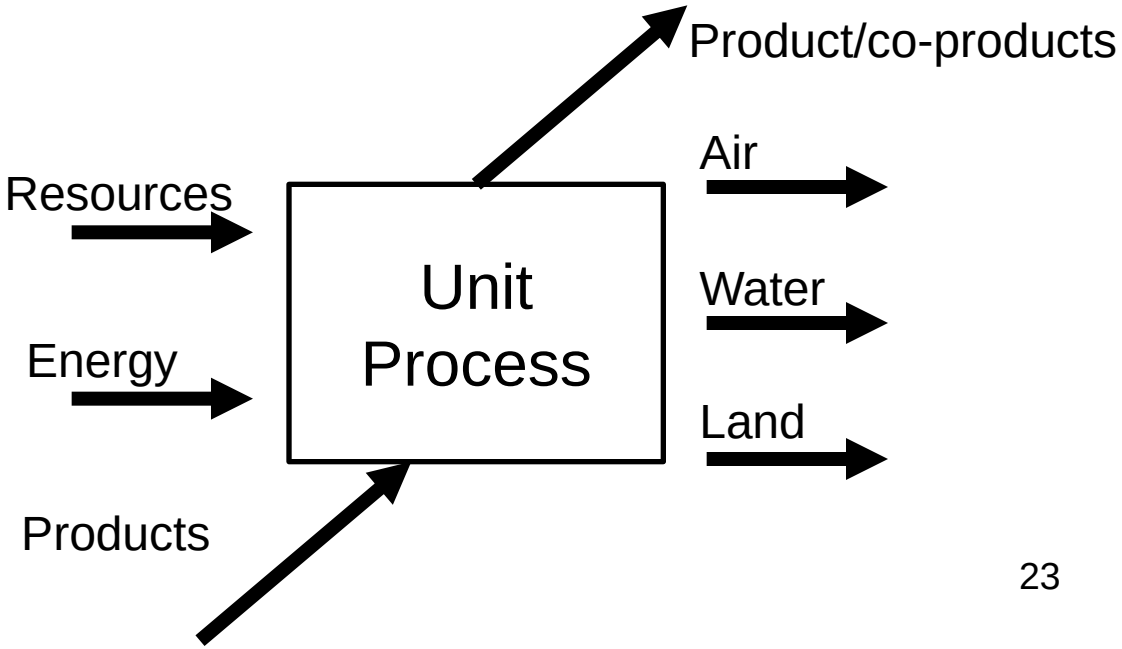
  - Really need to reflect on what you're trying to achieve in this study (ie. reflect on your Goal) to ensure study is as complex as necessary but as simple as possible.
  - Draw a process flow diagram of unit processes
    - Focus on what is required to meet functional unit
    - How far upstream and downstream are you considering?
      - Cradle-to-gate?
      - Cradle-to-grave?

Input and Outputs from/to:
- Nature
- Technosphere



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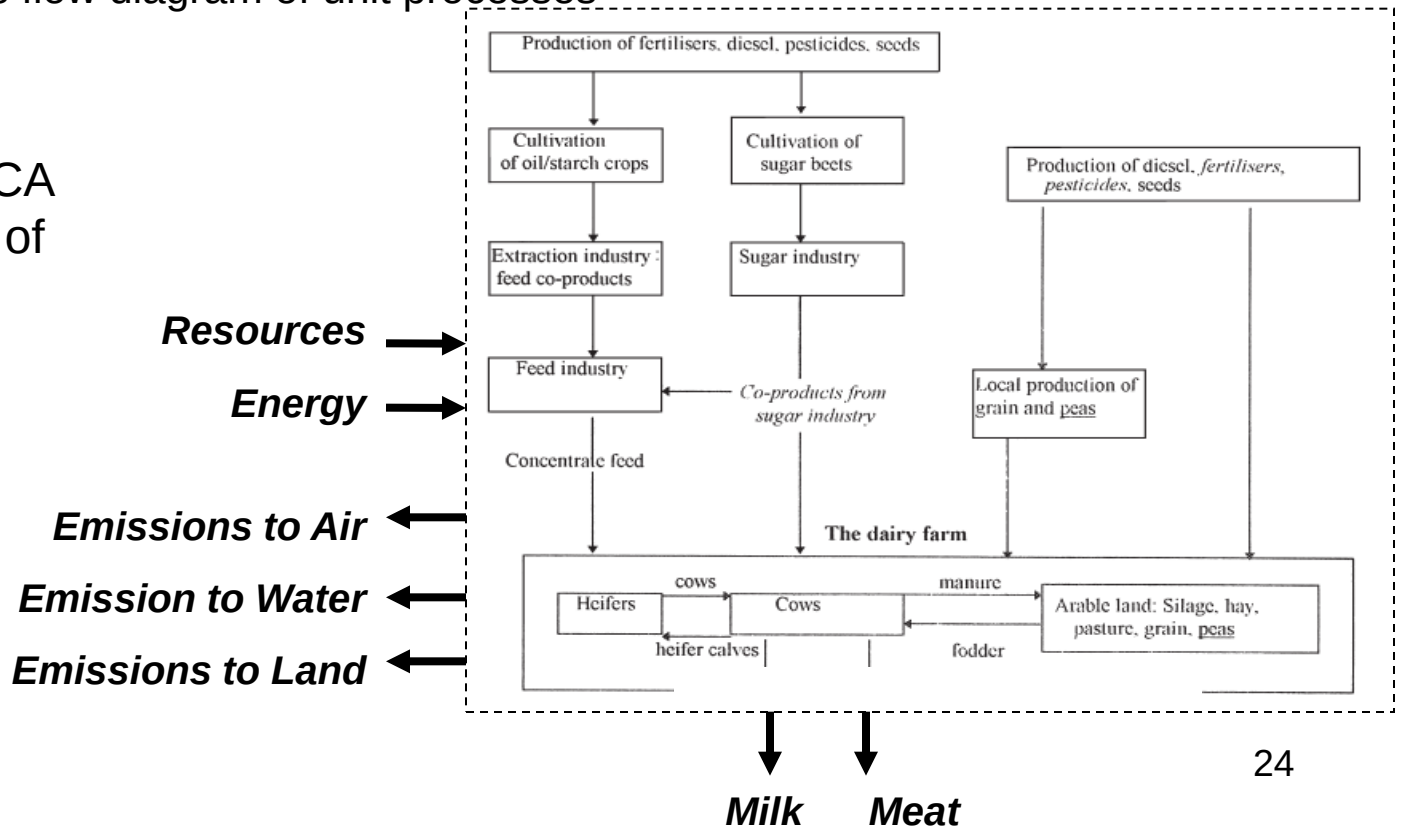
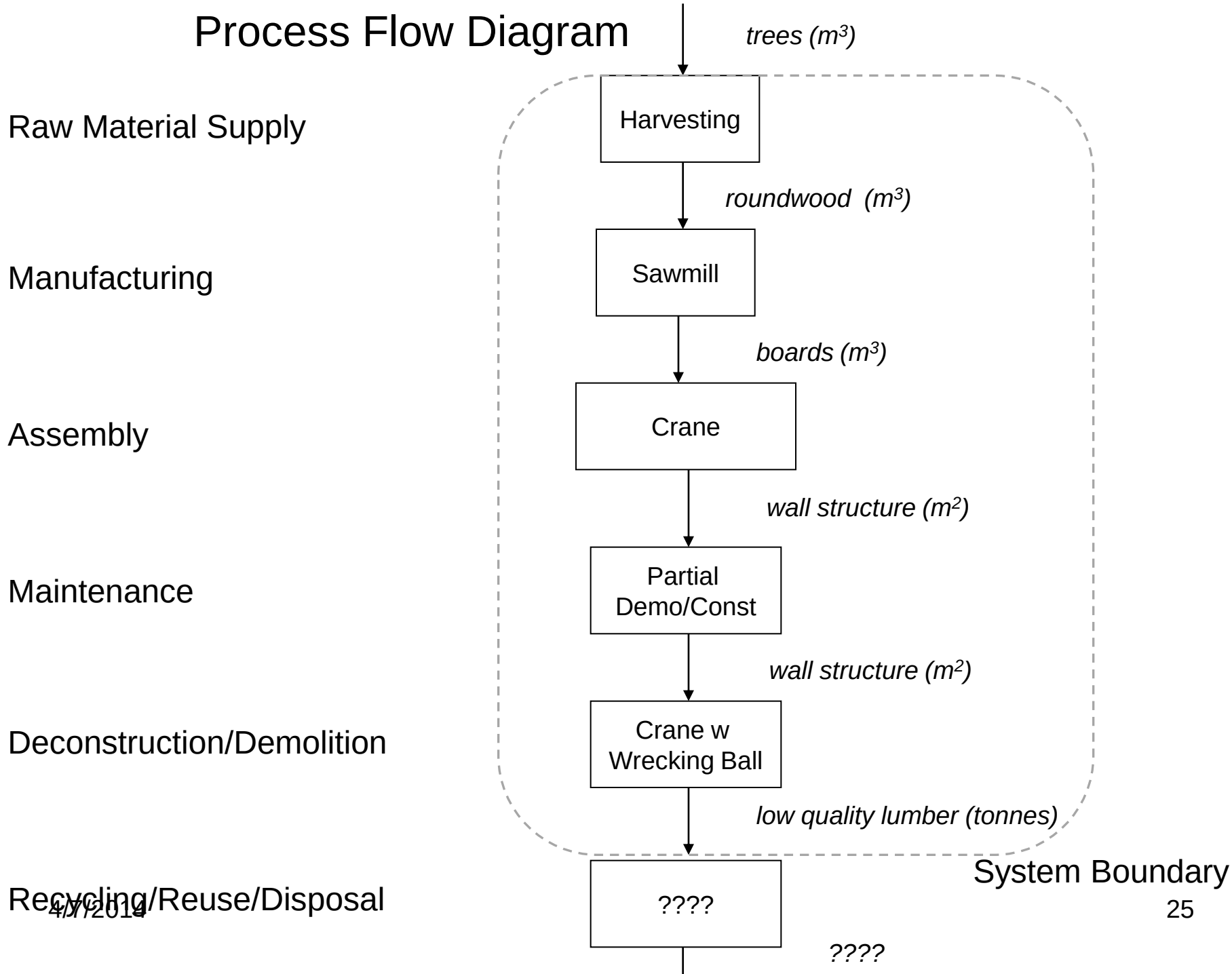
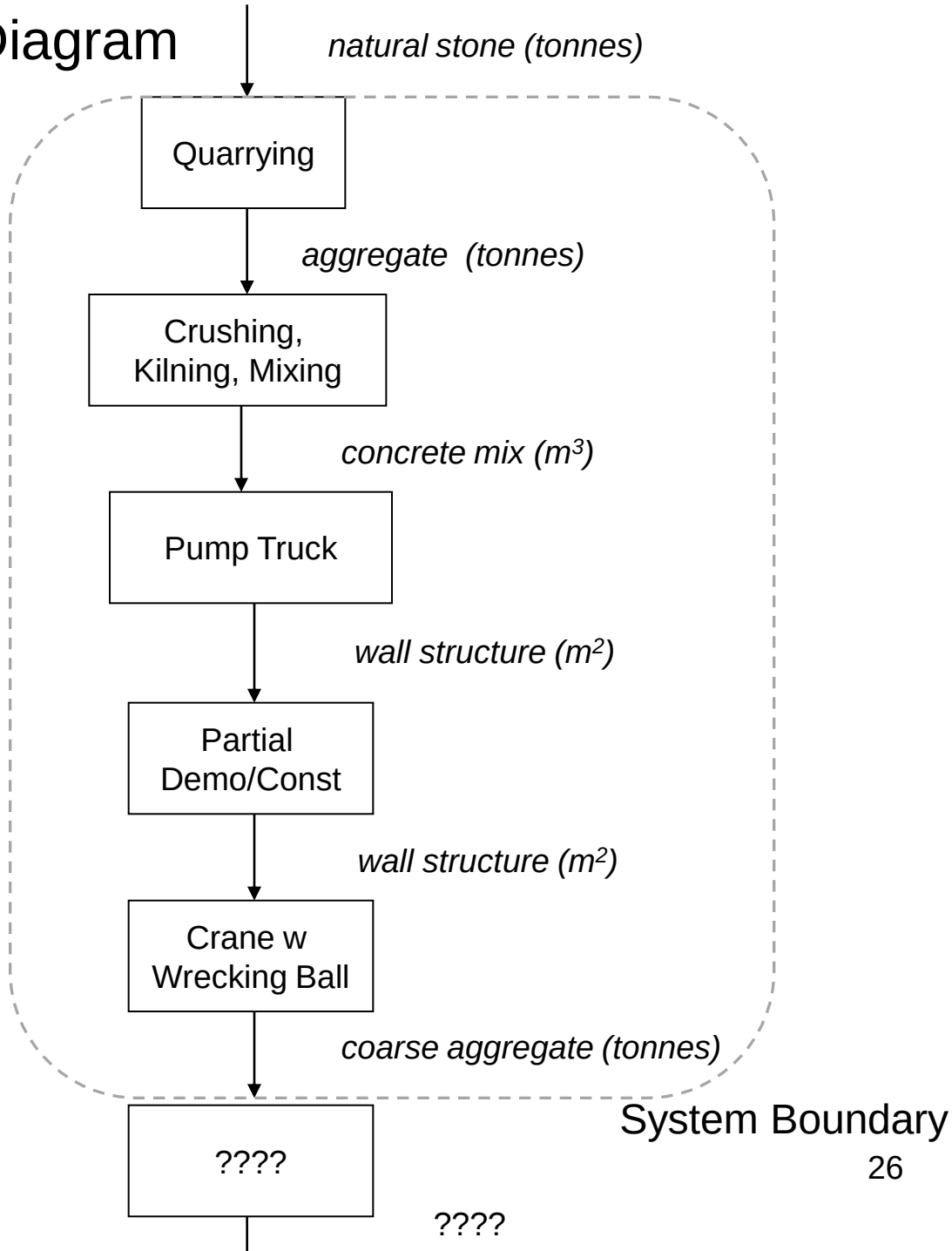
For example from LCA of system boundary of Organic vs. Conventional milk production.



Process Flow Diagram



Process Flow Diagram



Standardized Product System Boundaries

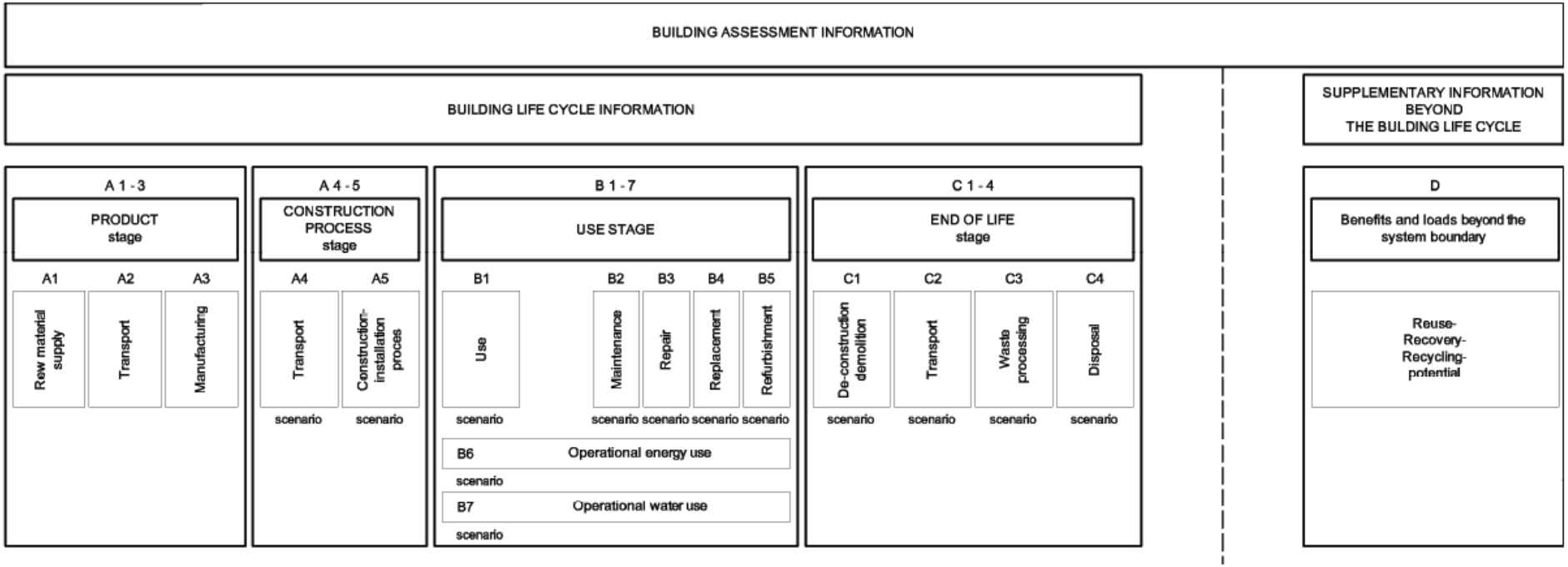


Figure 6 — Display of modular information for the different stages of the building assessment

BS EN 15978:2011
EN 15978:2011 (E)

Standardized Product System Boundaries

Example. Modularized building system boundary from Building LCA report.

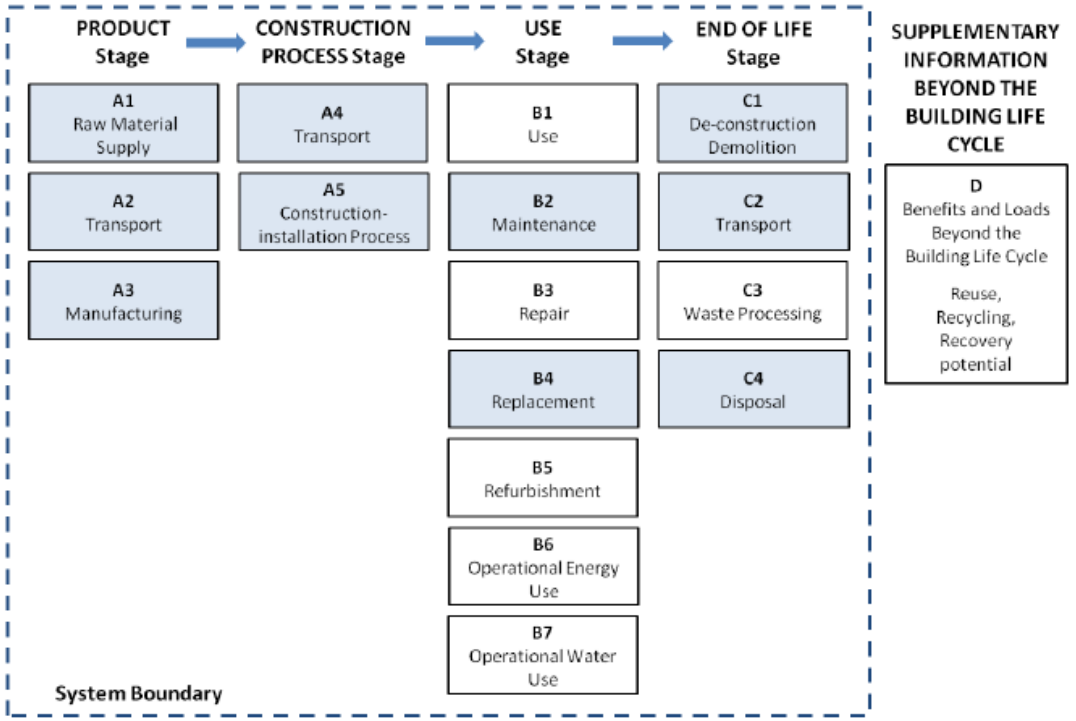
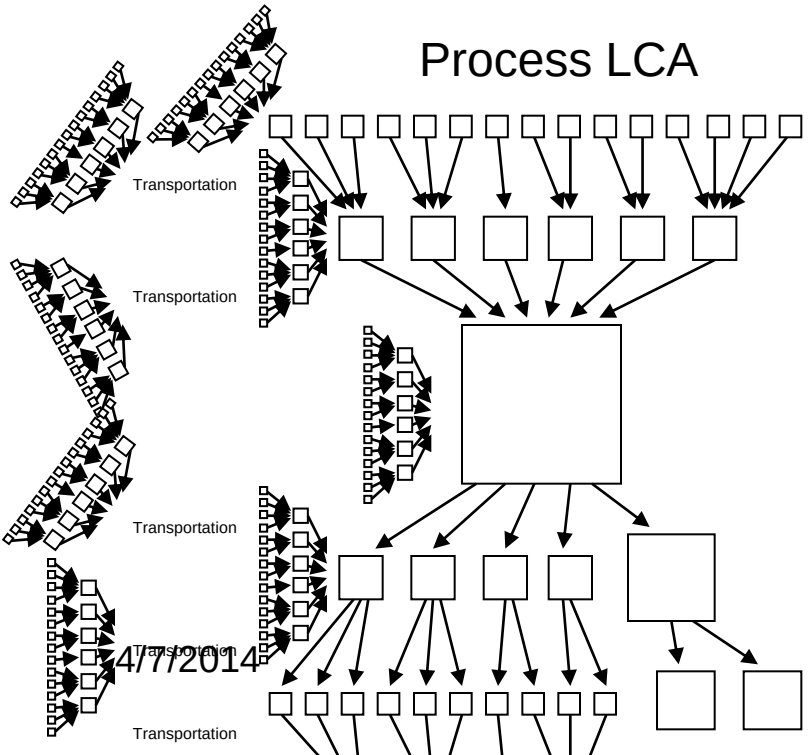


Figure 2: EN 15978 Building LCA Life Cycle Stages and Modules (assessment scope shown blue)

BS EN 15978:2011
EN 15978:2011 (E)

	Agriculture	Industry	Services	Exports	Consumers	Total
Agriculture	Trade within the sector	Agriculture supplies to industry	Agriculture supplies to services	Agriculture supplies to exports	Agriculture suplies to consumers	Total value
Industry	Industry supplies to Agriculture	Trade within the sector	Industry supplies to Services	Industry supplies to exports	Industry supplies to consumers	Total value
Services	Services supplies to Agriculture	Services supplies to Industry	Trade within the sector	Service supplies to exports	Services supplies to consumers	Total value
Agricultural Imports	Import of Agricultural goods	Import of Agricultural goods	Import of Agricultural goods			
Industrial Imports	Import of Industrial goods	Import of Industrial goods	Import of Industrial goods			
Import Services	Import of Services	Import of Services	Import of Services			
Total	Total costs	Total Costs	Total Costs			

Input Output LCA



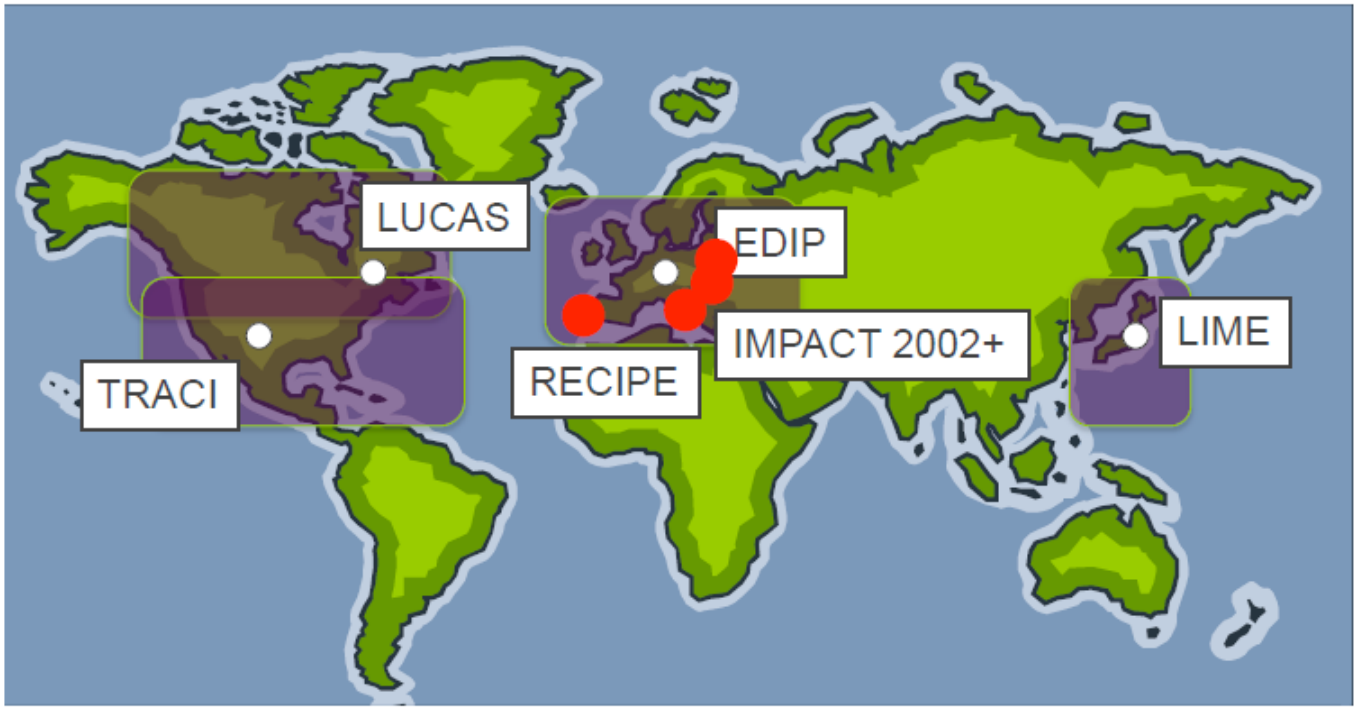
Advertising Sector

Wood Products Sector

Forestry Products Sector

Scope

- Impact categories selected and methodology of impact assessment
  - State the methodology used to characterize the LCI results and the impact categories that will address the environmental and other issues of concern.



Source: http://lcacenter.org/lcaxii/final-presentations/623.pdf

Scope

- Impact categories selected and methodology of impact assessment
  - State the methodology used to characterize the LCI results and the impact categories that will address the environmental and other issues of concern.
  - Dependent on Goal – ie. no need to report on impacts that do not meet the objectives, aren't relevant to the intended audience of applications of the study.
  - Methodologies may vary in the impact categories it considers. Methodologies that were developed for North America are;
    - TRACI – Tool for the Reduction and Assessment of Chemical and other environmental Impacts – developed by the US EPA
    - LUCAS – LCIA method Used for a CAnadian-Specific context – developed by CIRAIG

Impact Assessment Methods	
LUCAS (impact categories)	TRACI (impact categories)
climate change	climate change
ozone depletion	ozone depletion
abiotic resource depletion	acidification
acidification	smog formation
smog formation	ecotoxicity
ecotoxicity	eutrophication
human toxicity	human health cancer
land-use	human health noncancer
aquatic eutrophication	human health criteria pollutants
terrestrial eutrophication	fossil fuel depletion
	land use
	water use

Ex. Other IA Method (ReCiPe)

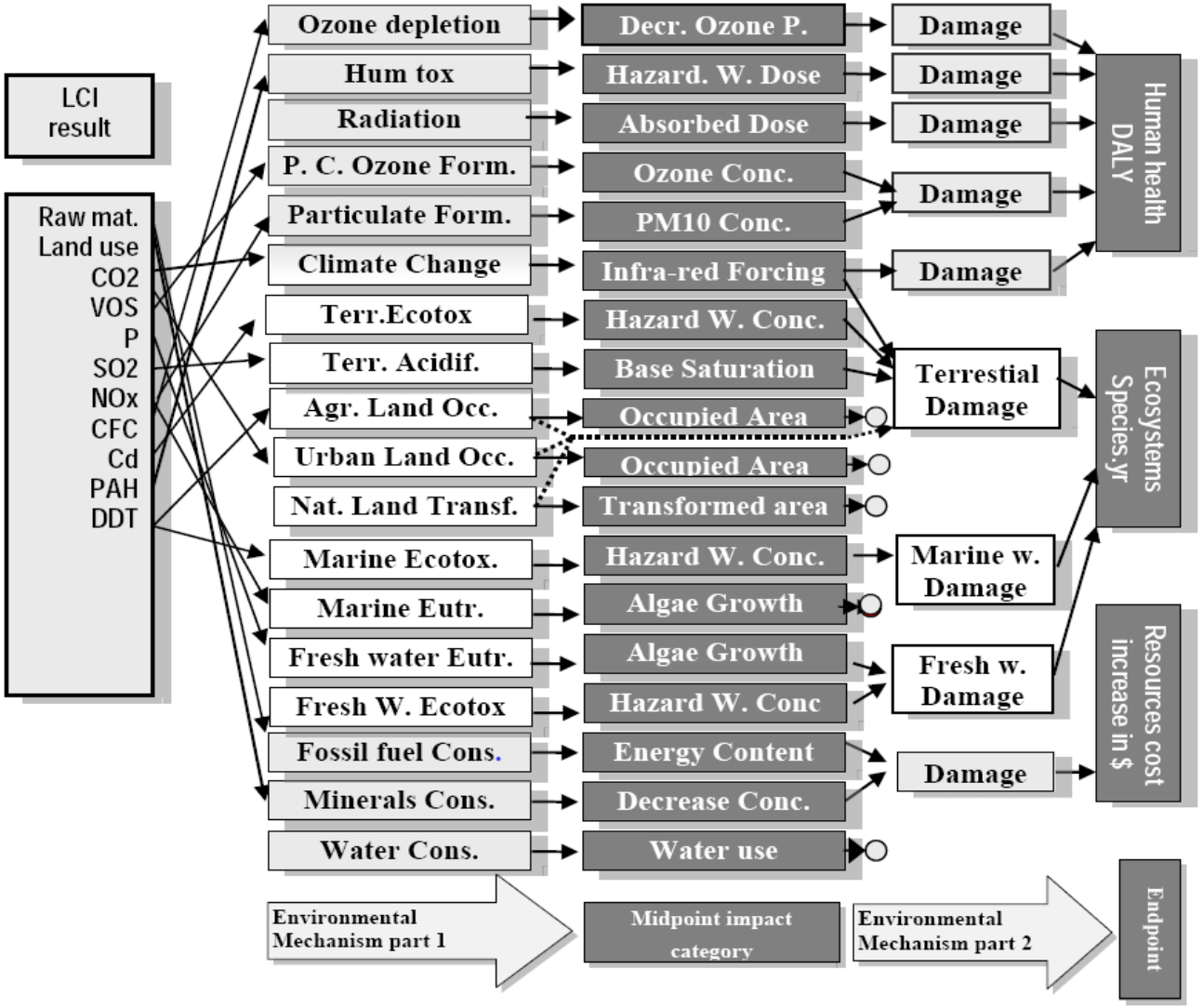
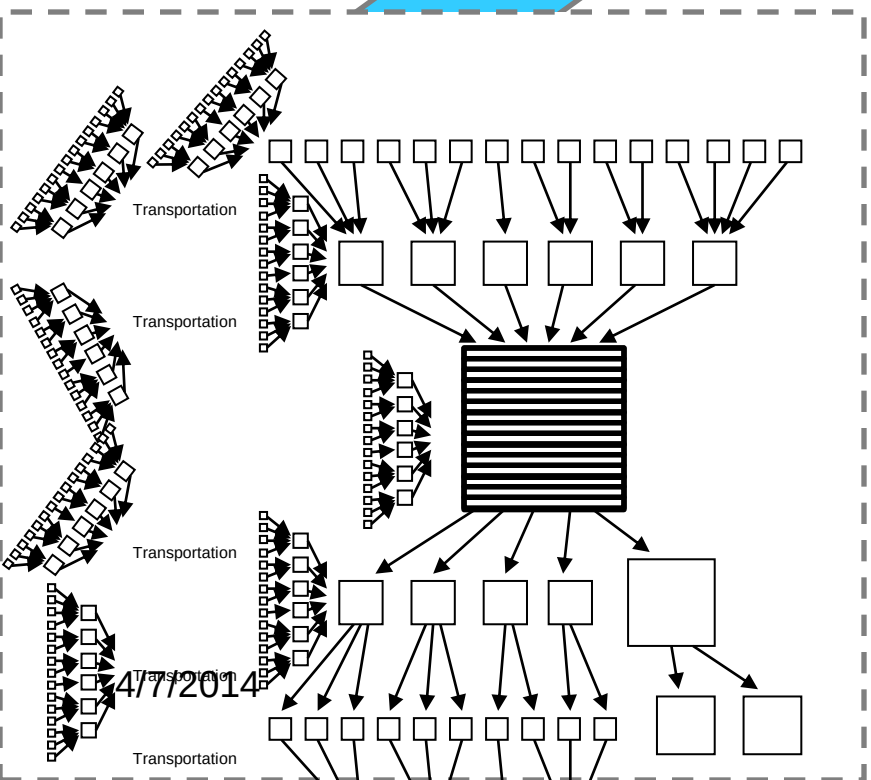
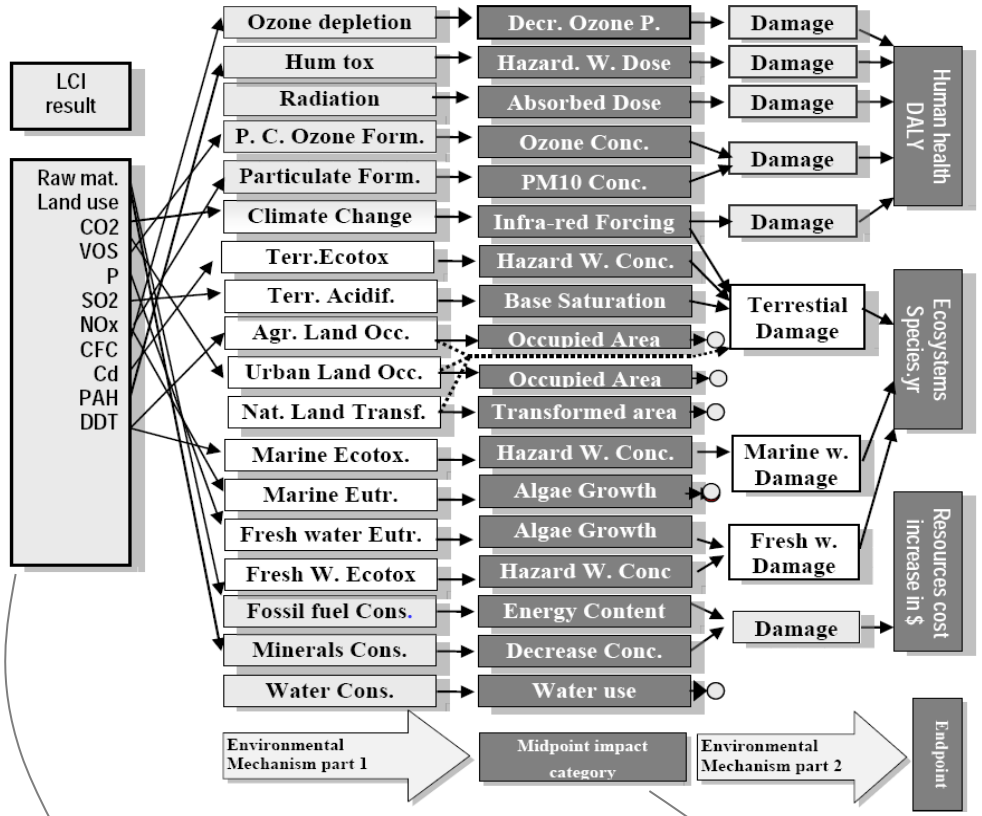


Figure 1.2: Relationship between LCI parameters (left), midpoint indicator (middle) and endpoint indicator (right) in ReCiPe 2008.



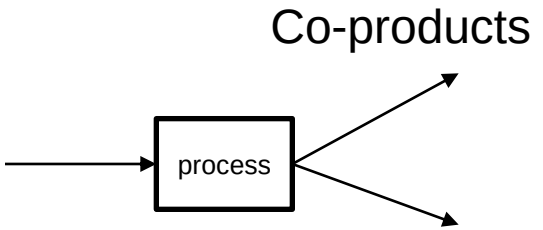


System Boundaries for;

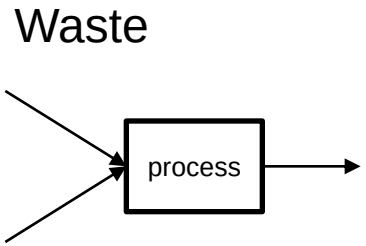
- inventory results
- impact categories

Scope

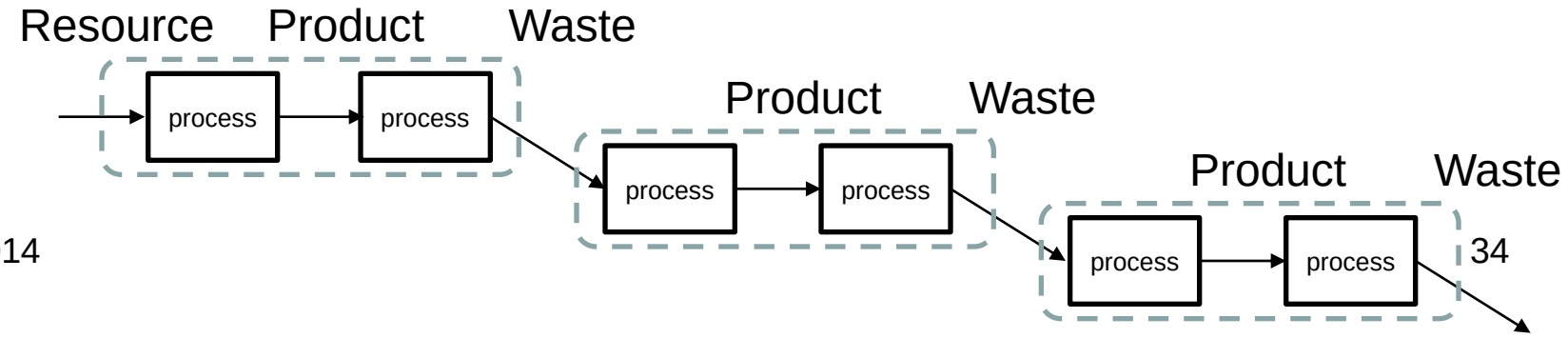
- Allocation procedures
  - Describes how the input and output flows of the studied product system (and unit processes within it) are distributed between it and other related product systems.
  - Three allocation scenarios to be aware of;
    1. A process outputs multiple products



    2. A waste treatment process has multiple inputs



    3. Open loop recycling



Scope

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  - Describes how the input and output flows of the studied product system (and unit processes within it) are distributed between it and other related product systems.
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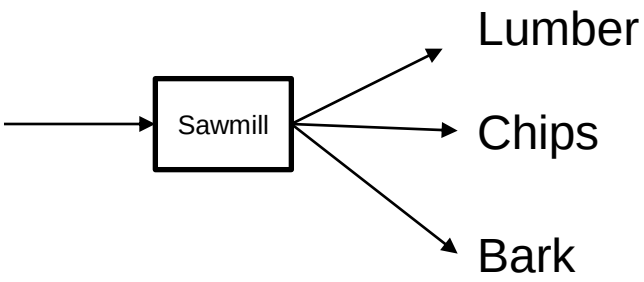
Co-products

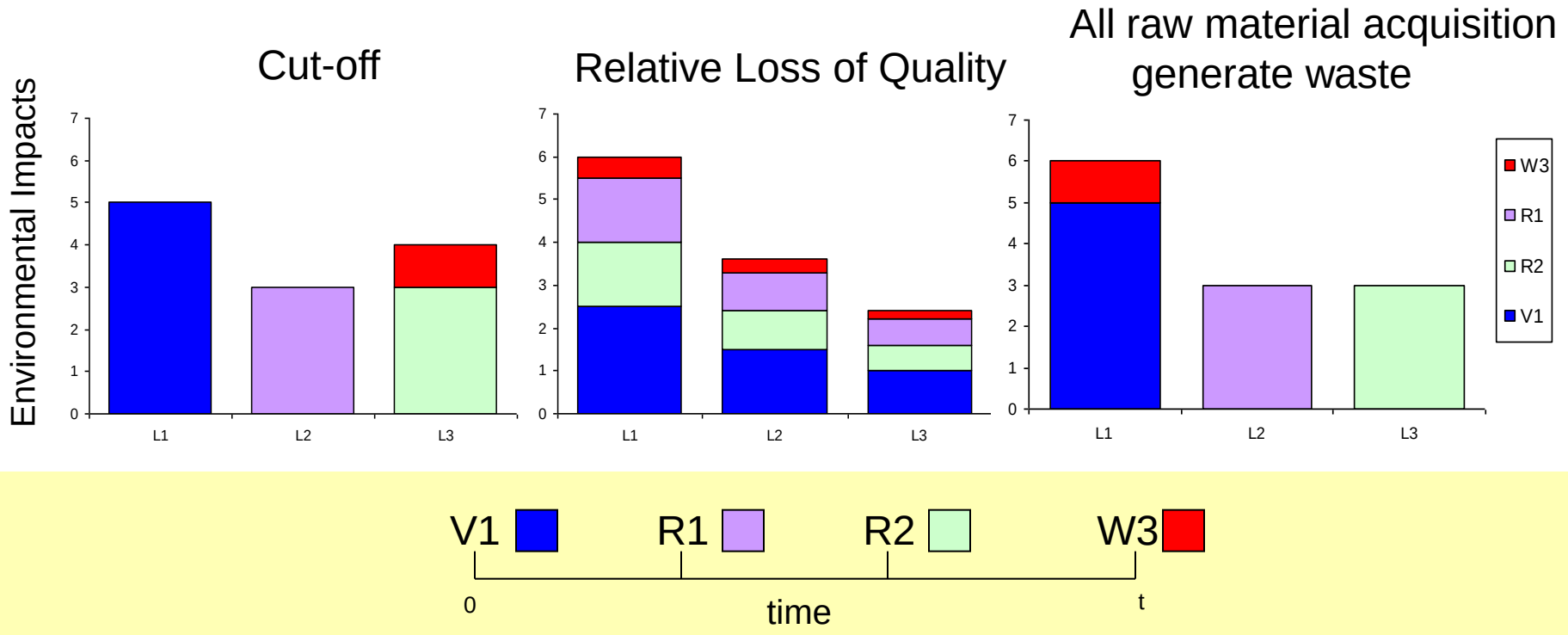


	Allocation Procedure	
Product	Mass	Economic
Lumber	50%	80%
Chips	30%	15%
Bark	20%	5%

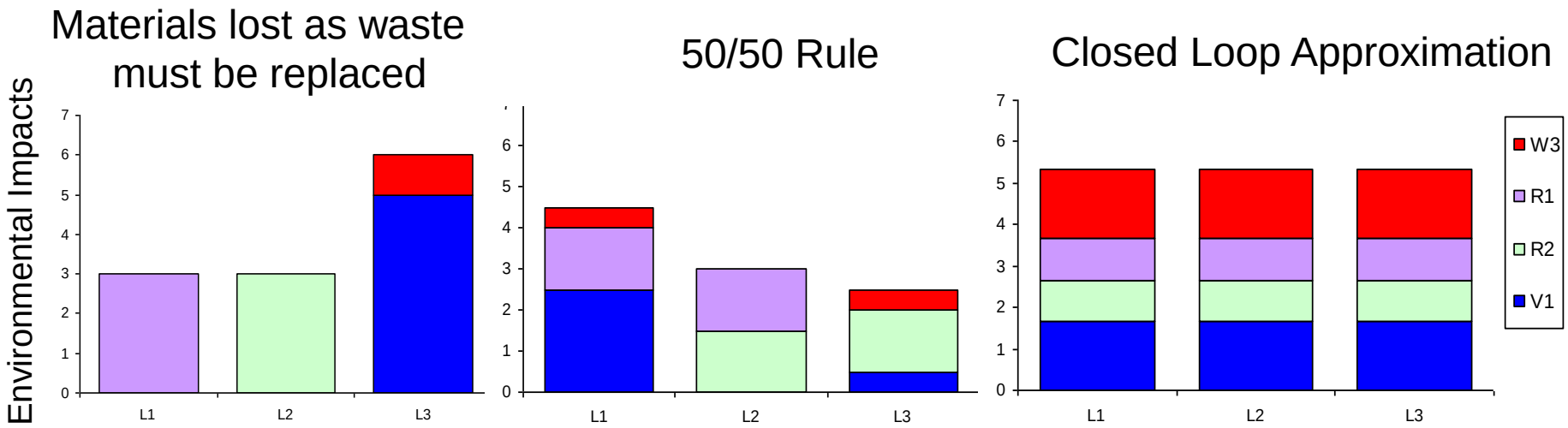
Production of lumber would look a look almost twice as good if mass allocation were used instead of economic.

Scope

- Allocation procedures
  - Open loop recycling
    - Cut-off
    - Relative loss of quality
    - All raw material acquisition generate waste
    - Material lost as waste must be replaced
    - 50/50 rule
    - Closed loop approximation


Environmental Impacts
Cut-off
Relative Loss of Quality
All raw material acquisition generate waste
0
1
2
3
4
5
6
7
L1
L2
L3
W3
R1
R2
V1

V1
R1
R2
W3
0
time
t


Environmental Impacts
Materials lost as waste must be replaced
50/50 Rule
Closed Loop Approximation
0
1
2
3
4
5
6
7
L1
L2
L3
W3
R1
R2
V1

Scope

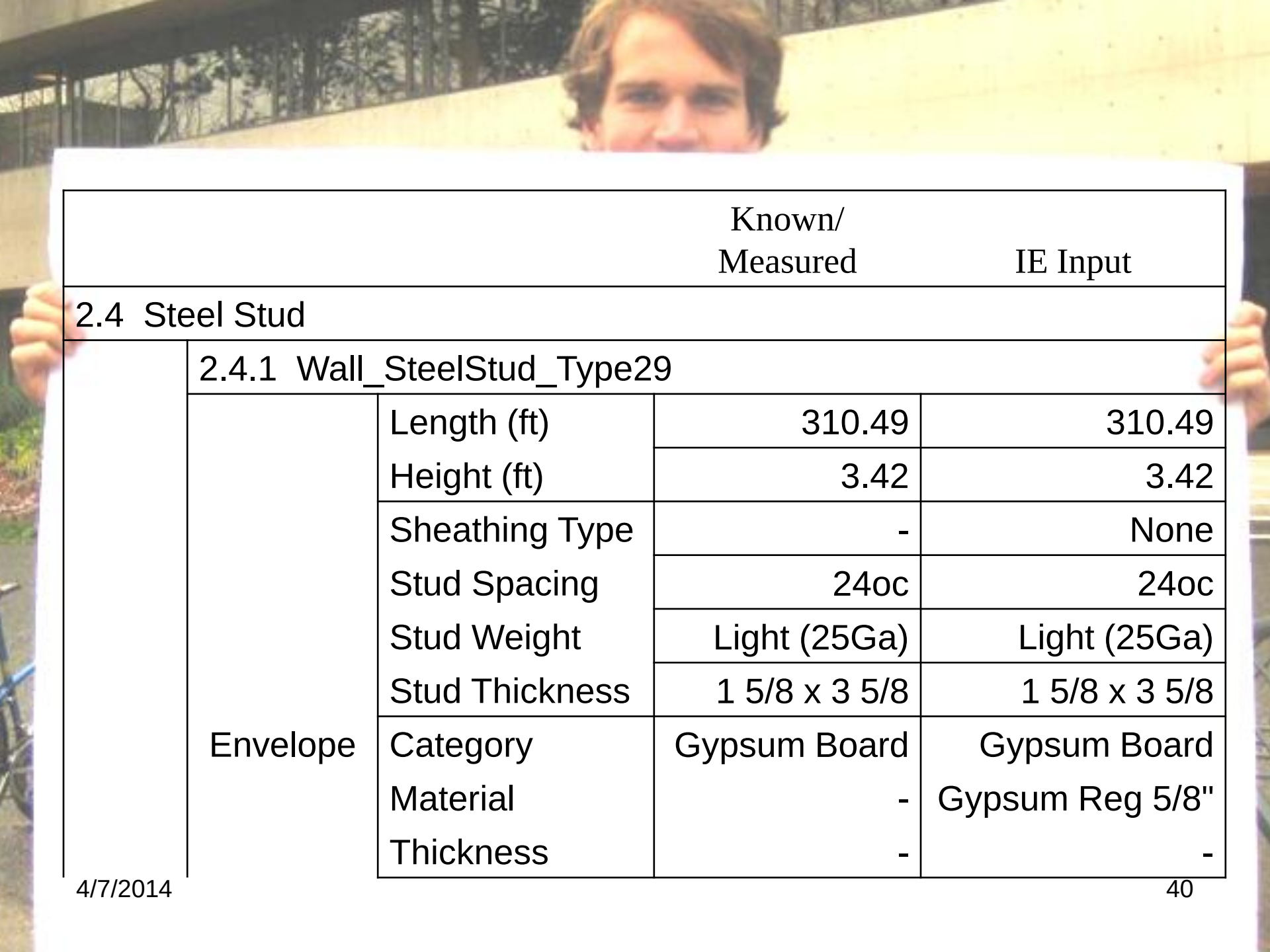
- Data requirements
  - Measured, calculated or estimated data needed to informed your modeling of unit processes.
  - Types
    - Primary Data – data collected directly from the specific process being modeled
    - Secondary Data – data for general processes reported by someone else
- Data quality requirements
  - Quantitative and qualitative characterization of quality of modeling methods and data used.
  - Ideally you should be able to address each of the following areas regarding the sourced data;
    - **Time related coverage** – is the data the right vintage and was it collected over an appropriate time span?
    - **Geographical coverage** – is the data collected from a comparable the geographical area?
    - **Technology coverage** – does it include the right technology(ies)?
    - **Precision** – is there a high variance in the dataset?
    - **Completeness** – is it well documented and does it encompass the entirety of the required data?
    - **Representativeness** – does the data simulate the appropriate circumstances?
    - **Consistency** – were the methods used to collect the data consistent with the relevant standards?
    - **Reproducibility** – is there enough documentation to enable a third party to understand the methods and data in order to repeat the study
    - **Uncertainty of the information** – is there enough information on the data to enable a qualitative and/or quantitative uncertainty analysis?
  - Make sure to consider the importance of the areas where you will be using sourced data (ie. make sure to collect the highest quality data on the aspects of your study that influence the results the most)
    - For example – concrete use in academic buildings.

Scope

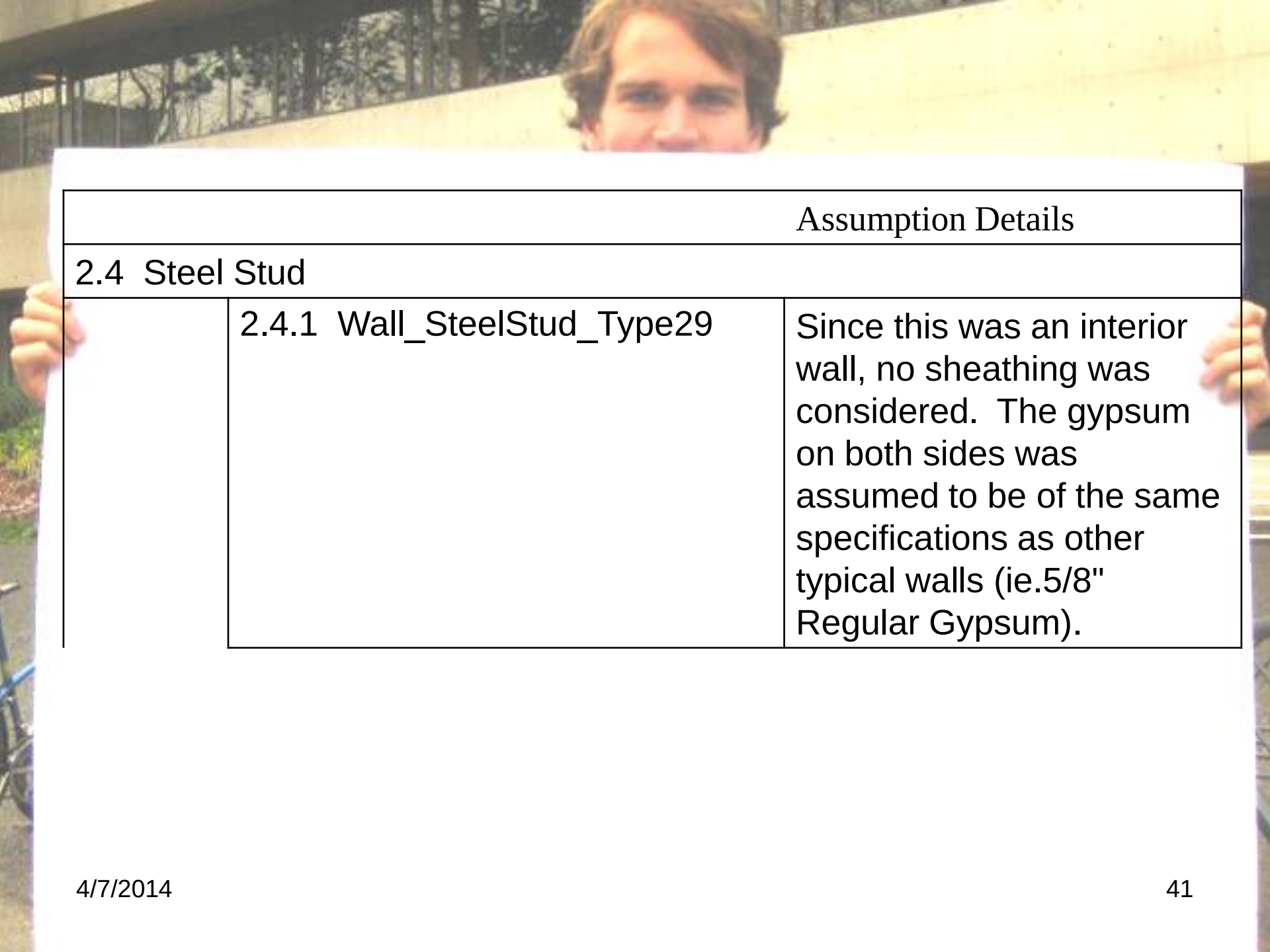
- Assumptions
  - Explicit statement of all assumptions used by the modeller to measure, calculate or estimate information in order to complete the study of the product system.
  - All LCA studies require assumptions. Just try and be as clear and concise as possible for your readers.
  - Make sure to do your research and be transparent with the sources of your assumptions. This will help increase the reproducibility and credibility of your study.

Example assumptions from Quantis XLERATOR LCA study;

System	Information or Data	Value or Assumption	Source
All	Optics assembly mass	0.15 kg	(Gagnon and Panaretos 2009)
	Number of uses annually per system	26,000 (500 per week)	Consistent with (Madsen 2007)
	Packaging Recycling Rates	Based on post-consumer averages for the US.	(U.S. EPA 2007)
	Incineration Rates	For all materials not recycled, it has been assumed that 20% of these materials are sent to incineration rather than landfilled.	(UNEP 2007)
	Shipping from production facilities to point-of use (all components)	750 km by truck, 750 km by ship	Consistent with (Environmental Resources Management 2001)
	Inbound shipping distances for all production components	750 km by truck, 750 km by ship	Consistent with (Environmental Resources Management 2001)
	Replacement of components for dryers and towel dispensors	1% of all parts over the lifetime of the unit.	Based on information from Excel Dryer, Inc. (Gagnon and Panaretos 2009)
	End-of-life transport distance and mode	200 km by heavy-duty diesel vehicle	Assumption



			Known/ Measured	IE Input
2.4 Steel Stud				
	2.4.1 Wall_SteelStud_Type29			
	Envelope	Length (ft)	310.49	310.49
		Height (ft)	3.42	3.42
		Sheathing Type	-	None
		Stud Spacing	24oc	24oc
		Stud Weight	Light (25Ga)	Light (25Ga)
		Stud Thickness	1 5/8 x 3 5/8	1 5/8 x 3 5/8
		Category	Gypsum Board	Gypsum Board
		Material	-	Gypsum Reg 5/8"
		Thickness	-	-



		Assumption Details
2.4 Steel Stud		
	2.4.1 Wall_SteelStud_Type29	Since this was an interior wall, no sheathing was considered. The gypsum on both sides was assumed to be of the same specifications as other typical walls (ie.5/8" Regular Gypsum).

Scope

- Limitations
  - Reinforce the Goal of the study by being clear about what your study can and cannot inform.
  - Usually related to Time period, Technology, Geography

- Type of critical review, if any
  - If you are planning on sharing your study publicly outside the study commissioner you need to have a third party review your work.
  - Critical review covers
    - Methods used are consistent with ISO
    - Methods used are scientifically and technically valid
    - Data used are in line with Goals of study
    - Interpretations reflect limitations and Goals of study
    - Report is transparent

- Type and format of the report required for the study
  - Follow ISO 14044 section 5.2 for Third part reports
  - Be as thorough and objective towards audience's expectations as possible.
  - Make sure to report all assumptions, data, methods, results, interpretations, conclusions and recommendations so that any third party can get enough information from your study to be able to reproduce it.

Goal & Scope

State the;

- Intended application
- Reasons for carrying out the study
- Intended audience
- Intended for comparative assertions

(ISO 14044:2006)

All information related to modeling that is to be carried out, specifically the;

- Product system to be studied
- Functions of the product system or, in the case of comparative studies, the systems
- Functional unit
- System boundary
- Impact categories selected and methodology of impact assessment, subsequent interpretation to be used
- Allocation procedures
- Data requirements
- Data quality requirements
- Assumptions
- Limitations
- Type of critical review, if any
- Type and format of the report required for the study

Further sources used in this presentation

- Quantis XLERATOR study
  - http://www.exceldryer.com/PDFs/LCAFinal9-091.pdf
- Organic vs. Conventional milk production study
  - http://www.csuchico.edu/agr/farm/dairy/environmentalstudies/Environmental%20impact%20assessment%20of%20conventional%20and%20organic%20milk%20production.pdf
- LUCAS paper
  - http://www.springerlink.com/content/082511u252422303/fulltext.pdf
- TRACI paper
  - http://mitpress.mit.edu/journals/pdf/jiec_6_3_49_0.pdf
- Transportation study
  - http://www.its.berkeley.edu/publications/UCB/2009/vwp/UCB-ITS-VWP-2009-2.pdf
- ISO 14044:2006 & 14040:2006
- Hitch Hiker's Guide to LCA
  - http://openlibrary.org/books/OL22114569M/hitch_hiker%27s_guide_to_LCA